

REMARKS

Claims 1-20, 22-24 and 26-29 are amended. Claims 21 and 25 are canceled without prejudice or disclaimer. Claim 30 is added.

Support is found, for example, in the specification on page 12, lines 11-12; page 19, Table 1, steel nos. 2, 8, 9, 12, 16, 21 and 24; page 20, Table 1, steel nos. 14 and 17; and page 22, Table 2, steel no. 5. Hence no issues of new matter are presented.

Accordingly, upon entry of the amendment, which is respectfully requested, claims 1-20, 22-24 and 26-30 will be all of the claims pending in the application.

I. Rejection of claims 1-29 under 35 U.S.C. § 112, first paragraph

On page 2 of the Office Action, claims 1-29 are rejected under 35 U.S.C. § 112, first paragraph, as containing subject matter which was not described in the specification in such a way as to reasonably convey to one skilled in the relevant art that the inventor(s), at the time the application was filed, had possession of the claimed invention.

The Examiner asserts that the expression "a hardness not less than Hv 502" in claims 1, 11, 24 and 25 is not supported by the specification as originally filed. The Examiner also asserts that a point in a Table does not support an open range not disclosed in the specification as originally filed.

Applicants respectfully traverse the rejection and submit that there is support in the specification for the expression "a hardness not less than Hv 502". Specifically, Table 2 at page 22 of the present specification shows that steel no. 17 has a hardness of 502, and the hardness of the other steels are higher than 502. Therefore, there is support in the specification as originally filed for the expression "a hardness not less than Hv 502", based on Table 2.

Notwithstanding the above, the claims are amended herein to recite an upper limit of the Hv range of 632 to further clarify the invention, which is supported by the present specification on page 22, Table 2, steel no. 5.

Accordingly, Applicants respectfully request withdrawal of the rejection.

II. Rejection of claims 1-7, 11-16 and 22-29 under 35 U.S.C. § 103

On pages 3-4 of the Office Action, claims 1-7, 11-16 and 22-29 are rejected under 35 U.S.C. § 103 as being unpatentable over Pinnow et al.

The Examiner asserts that Applicants recite elements not disclosed in the cited references that include zero, which suggests that the elements do not have to be present. Therefore, the Examiner asserts that the subject matter as a whole would have been obvious to one of ordinary skill in the art. In addition, the Examiner asserts that it is well settled that there is no invention in the discovery of a general formula if it covers a composition described in the prior art.

In addition, with respect to the Co content, the Examiner takes the position that there is no difference between 6.9 wt% and 7 wt%, and thus, the range is obvious since one of ordinary skill in the art would expect them to have the same properties.

The Examiner further takes the position that the claims require Si, Mn and Ti in amounts to the extent that they would satisfy the formula, which includes zero.

Applicants respectfully submit that Pinnow et al does not teach or suggest the presently claimed invention. The present claims are directed to a maraging steel strip. The claimed maraging steel strip can be applied to a power transmission belt. On the other hand, Pinnow et al discloses a maraging steel block die that is produced by a powder-metallurgical method. In addition, Pinnow et al's maraging steel is free of titanium. See Abstract. This is because titanium is oxidized when a maraging steel containing titanium is produced by the powder metallurgical method.

Further, in Pinnow et al, none of the easily oxidizable elements is positively added in the disclosed embodiments. In the steel strip of the present invention, aluminum is an important element and is positively added to improve the mechanical strength of the claimed steel. In the present invention, aluminum is added in an amount to form the Ni-Al-intermetallic compound.

Pinnow et al is silent on the idea of strengthening the maraging steel by the Ni-Al intermetallic compound.

In addition, in the steel strip present invention, Si and Mn are added as essential elements. Si and Mn form intermetallic compounds and have the effect of refining the micro-structure of steel, as well as Al.

Further, the steel strip of the present invention has a cross-sectional area that is significantly smaller than the die block of Pinnow et al produced by the powder metallurgical method. This is a significant distinguishing feature of the present invention because in the case where the steel strip contains residual nonmetallic inclusions, such as nitrides, fatigue rupture is triggered at the inclusions. The smaller the cross sectional area is, the earlier the strip is ruptured. Thus, in the present invention, the elements of O (oxygen) and N (nitrogen) are limited to very low levels as well as P (phosphorus) and S (sulfur). These are essential features of the steel strip of the present invention having a small sectional cross sectional area. Therefore, one of ordinary skill in the art would not have a reasonable expectation of success in achieving the claimed invention based upon the disclosure of Pinnow et al.

Another distinguishing feature of the claimed invention is the recited hardness range of not less than Hv 502 to not more than Hv 632. The hardness of the die block of Pinnow et al is shown below:

"PM Maraging Steel, Titanium-Free: No. 92-93" (Pinnow)

C	Mn	P	S	Si	Ni	Co	Mo	Cu	Ti	B	N
0.00	0.0	0.00	0.00	0.0	17.4	10.6	4.8	0.0	-	0.00	0.00
1	2	4	2	2	0	0	9	2		1	2

Steel No. 92-93 does not contain Al while containing Co in a high amount of 10.60 wt%

In the present specification, the test results of the hardness of Titanium-Free maraging steel in Table 2, in which the maraging steel was subjected to aging treatment are disclosed. See the

following comparison between the results of Pinnow et al above and the steel strip of the present invention.¹

(a) Present invention: 502-632 Hv

(b) Titanium-Free (Pinnow et al): 48-50.5HRC (=484-520 Hv)

From this, it can be understood that the steel strip of the present invention can have a hardness that is substantially identical to or higher than that of the steel of Pinnow et al. This is a technical advantage by virtue of improved mechanical strength caused by additives Al, Si and Mn even if the Co amount is lowered to not more than 6.9%, wherein Co contributes to precipitation strengthening (see page 10, line 26 to page 11 line 3 of the present specification). In this regard, it should be noted that the higher the hardness of the steel is, the more the mechanical strength increases. Therefore the high hardness of steel means that the steel has a high strength.

Another distinguishing feature of the present invention, is the amount of the elements in the claimed steel strip. In the present invention, the amount of Co is not more than 6.9%. The alloying element Co has a significant effect of the improvement of strength of steel and is expensive. In the present invention, the amount of Ti is not more than 0.05%. Ti also has a significant effect on the improvement of strength of steel. Further, Al is positively added in order to compensate for the decreased strength of the steel due to the decreased amounts of Co and Ti. The balanced amounts of the additive strengthening elements are controlled by the formula as recited in the present claims.

For example, with regard to the Titanium-Free, steel No. 92-33 of Pinnow et al, the value according to the formula is 8.52 because of a higher amount of Co. Therefore, a hardness value of Hv 484 to Hv 502 was obtained.

¹ In the present invention, the aging treatment was conducted at 490° C which is compared to the invention of Pinnow et al conducted at 900° F (480° C), which is the closest example to 490° C.

In the present invention it is important to determine a balanced combination of alloy components by using the formula of the invention even if the Co amount is low. Specifically, in the present invention, not only an amount of the respective alloying element is controlled but also the value of the formula $((3\text{Si} + 1.8\text{Mn} + \text{Co}/3 + 2.6\text{Ti} + 4\text{Al}) = 8.0 \text{ to } 13\%)$ according to the invention is controlled, whereby the inventive steel strip can have a high hardness (strength), so that a maraging steel strip, which is not expensive and high in strength, can be obtained.

Pinnow et al is silent on the technical idea of balancing alloying elements in the presently claimed amounts. Thus, one of ordinary skill in the art would not have had a reasonable expectation of achieving the maraging steel strip of the present invention, based on the disclosure of Pinnow et al.

Accordingly, Applicants respectfully request withdrawal of the rejection.

III. Rejection of claims 7 and 17 under 35 U.S.C. § 103(a)

On pages 4-5 of the Office Action, claims 7 and 17 are rejected under 35 U.S.C. § 103(a) as being unpatentable over Pinnow et al, and further in view of Whitaker.

The Examiner acknowledges that Pinnow et al does not disclose grain size, but cites Whitaker as teaching that refined grain size would improve maraging steel strength and ductility. Therefore, the Examiner asserts that it would have been obvious to one of ordinary skill in the art to refine the grain size in order to improve/provide maraging steel strength and ductility.

Applicants respectfully traverse the rejection and submit that claims 7-10 and 17-20 depend from claims 1 and 11, respectively, and are therefore distinguished over Pinnow et al for at least the reasons discussed above. Whitaker does not cure the deficiencies of Pinnow et al and therefore the present invention is not obvious over the combination of Pinnow et al and Whitaker.

Further, Whitaker discloses a variant of the maraging class of steels that are used at a low temperature and are composed of 12 Ni-4Co-2Mo-0.5Ti-Fe. These steels are different from the presently claimed invention in the amounts of Mo and Ti. Further, the steels disclosed by Whitaker

are different from the steel disclosed by Pinnow et al in the amount of Ti.

Since Ti is oxidized when a maraging steel containing Ti is produced powder-metallurgically, Pinnow et al's maraging steel is Ti-free. Thus, Pinnow et al does not teach or suggest adding an amount of 0.5% Ti in its maraging steel.

In the present invention, Ti has a detrimental element because it forms inclusions of TiN or Ti (C, N) thereby deteriorating the fatigue strength of the steel, especially in a super high cycle vibration range exceeding 10^7 cycles, which is deemed to be a fatigue limit. Thus, the content should be low as an impurity in the case where steel is desired to have good fatigue strength. Further, Ti is liable to form a stable thin oxide film on the surface of the steel. The Ti-oxide film prevents a nitriding reaction, so that it becomes hard to obtain enough compression residual stress at the nitrided surface of the steel. See pages 11-12 and the present invention. Therefore, in view of easy nitriding and ability to obtain higher compression residual stress at the nitrided surface of the steel, Ti is a detrimental impurity element and should be limited to a lower content level, i.e., not more than 0.05%. Thus, one of ordinary skill in the art would not have been motivated to combine Pinnow et al and Whitaker with a reasonable expectation of success in achieving the claimed invention.

Accordingly, Applicants respectfully request withdrawal of the rejection.

VI. Rejection of claims 8-10 and 18-21 under 35 U.S.C. § 103(a)

On pages 5-6 of the Office Action, claims 8-10 and 18-21 are rejected under 35 U.S.C. § 103(a) as being unpatentable over references as applied to claims above, and further in view of JP 62-080225 (abstract) or JP 63-026345 (abstracts).

The Examiner acknowledges that Pinnow does not disclose nitriding and residual compression stress, but cites JP 62-080225 and JP 63-026345 as teaching that compression stress would be induced by nitriding to improve bending fatigue strength.

Applicants respectfully traverse the rejection for the reason that claims 8-10 and 18-21 depend from claims 1 and 11, respectively, and are distinguished over the combination of Pinnow et

al and Whitaker as discussed above. Further, JP '225 and JP '345 do not cure the deficiencies of the combination of Pinnow et al and Whitaker. Specifically, JP '225 and JP '345 only disclose subjecting a maraging steel to a nitriding treatment and are silent on the chemical compositions thereof. Therefore one of ordinary skill in the art would not have been motivated to combine the references.

Even if one were to combine the references as suggested by the Examiner, one would only expect to obtain a resultant maraging steel die that contains about 11% Co, which is subjected to a nitriding treatment while it is not strengthened by an intermetallic compound of NiAl. Thus, one of ordinary skill in the art would not have had a reasonable expectation of achieving the claimed invention.

Accordingly, Applicants respectfully request withdrawal of the rejection.
with a reasonable expectation of success in achieving the claimed invention.

VII. Conclusion

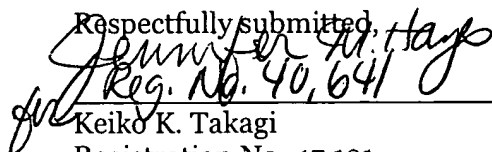
In view of the above, reconsideration and allowance of this application are now believed to be in order, and such actions are hereby solicited. If any points remain in issue which the Examiner feels may be best resolved through a personal or telephone interview, the Examiner is kindly requested to contact the undersigned at the telephone number listed below.

The USPTO is directed and authorized to charge all required fees, except for the Issue Fee and the Publication Fee, to Deposit Account No. 19-4880. Please also credit any overpayments to said Deposit Account.

SUGHRUE MION, PLLC
Telephone: (202) 293-7060
Facsimile: (202) 293-7860

WASHINGTON OFFICE
23373
CUSTOMER NUMBER

Date: November 13, 2003

Respectfully submitted,

for Reg. No. 40,641
Keiko K. Takagi
Registration No. 47,121